MONTHLY WEATHER REVIEW

Editor, W. J. HUMPHREYS

VOL. 63, No. 9
W. B. No. 1165

SEPTEMBER 1935

CLOSED NOVEMBER 4, 1935
ISSUED DECEMBER 9, 1935

THE HURRICANE OF AUGUST 31 TO SEPTEMBER 6, 1935

By W. F. McDONALD

[Weather Bureau, Washington, October 1935]

The full life history of the hurricane that devastated some of the Florida Keys on the afternoon and night of Labor Day, September 2, 1935, covers almost 2 weeks.

The first indications of conditions favorable to the origin of this disturbance were noted during the last 2 or 3 days of August, to the eastward and northward of Turks Islands; but it was not until August 31 that a definite depression appeared, near Long Island in the southeastern Bahamas, and deepened rapidly as it moved westward. The identity of the disturbance can be clearly followed from that region, over a long path around Florida and across the South Atlantic States to the North Atlantic Ocean, where, off southern Greenland, it was lost on September 10 by merging with a cyclone of extratropical origin This path in its entirety is shown on chart X.

Hurricane intensity was doubtless reached by the developing disturbance near the south end of Andros Island on September 1. Hurricane winds were last reported along the track on September 8 as the storm was moving northeastward over the Atlantic Ocean.

The vortex was at the stage of maximum violence, though still of small diameter, as it crossed the Florida Keys between Key West and Miami, September 2, moving northwestward. (See chart IX.) The central minimum barometer there was probably somewhat below 27 inches, as indicated by readings of three aneroids on the Keys, the values ranging from 26.75 to 26.98. Effort is being made to secure one or more of these instruments for testing, because any authenticated pressure value below 27 inches will constitute a new low record for the Western Hemisphere.

Attendant winds on September 2 were of phenomenal violence as is shown by physical effects almost equivalent to those experienced in tornadoes. One observer reported his house partially demolished by a wind-driven beam, 6 by 8 inches in section and 18 feet long, which was blown 300 yards from another building; this occurred at a time nearly 3 hours in advance of arrival of the calm center. It was this observer's impression that the winds were still more violent afterward. The lenses and ⅜-inch protecting glass of Alligator Reef Lighthouse, 135 feet above sea level, were reported to have been completely destroyed by the hurricane; and it is unlikely that this destruction could have been produced by flying debris.

It seems safe to estimate that winds of 150 to 200 miles per hour occurred near and over the Keys, with gusts probably exceeding 200 miles per hour.

Over a distance of about 30 miles, from the settlement of Tavernier (about 25°01′ N., 80°32′ W.) to Vaca Keys, the destruction of buildings, roads, viaducts, and bridges was practically complete. Much of this damage was caused by the overwhelming depth and strong washing flow of the storm tide that piled up on the Keys under the driving power of the storm. The tracks of the Florida East Coast Railroad were completely destroyed where they crossed between islands and were shifted bodily off their roadbed over long stretches on the Keys. An 11-car train, sent to Lower Matecumbe Key in an effort to rescue inhabitants, was washed from the tracks and only the locomotive withstood the force of wind and tide.

The disposition of debris and nature of the erosion of the railroad embankments clearly indicate that the destructive tide flowed with intense effect over the Keys from southeast to northwest, in the direction of advance of the storm center.

As is usually the case, the destructive effects extended considerably farther to the right than to the left of the path of the center. Had there been no accompanying tide, the damage undoubtedly would have been severe but by no means so complete as that resulting from the tidal inundation. The track and crossties of the railroad were in one stretch washed off a concrete viaduct 30 feet above ordinary water level, but wave action superimposed on the tide no doubt play tides part in this destruction. Reports agreed in the description of the great rapidity with which the rise of the sea came in from the southern side of the Keys as a "wall of water" or a "high wave."

The Danish motorship *Leise Maersk* was carried over Alligator Reef and grounded nearly 4 miles beyond, after being totally disabled by the wind and sea, with engine room flooded. Captain Richard Morthensen described the grounding as follows: "Ship struck outer edge of Alligator Reef 9 o'clock (p. m.) and was carried over the reef by a wall of water inland 3¾ miles through the northward force of the wind, which was terrible." None of the crew was lost, though all superstructures were wrecked. The ship was salvaged September 20.

The American steamship *Dixie* was also carried aground somewhat farther north, on French Reef, without loss of life; this ship was refloated on September 19 and towed to New York. The American tanker *Pueblo* drifted helplessly in the storm from 2 to 10 p. m. of September 2; she went out of control near 24°40′ N., 80°25′ W., and was carried completely around the storm center, finding herself in 8 hours about 25 miles northeastward of her original position, and just barely able to claw off Molasses Reef as the force of the storm began to abate. The lowest barometer reading on the *Dixie* was 27.28 inches (corrected), and on the *Pueblo*, 27.18 inches (uncorrected).

The passage of the hurricane is graphically described in a report submitted by J. E. Duane, cooperative observer for the Weather Bureau and in charge of a fishing camp on Long Key, over which the center passed. Extracts

from his report follow, in the chronological order of his observations:

September 2: 2 p. m.—Barometer falling; heavy sea swell and a high tide; heavy rain squalls continued. Wind from N. or NNE., force 6.

3 p. m.—Ocean swells had changed; this change noted was that large waves were rolling in from SE., somewhat against winds which were still in N. or NE.

4 p. m.—Wind still N., increasing to force 9. Barometer dropping 0.01 every 5 minutes. Rain continued.

5 p. m.—Wind N., hurricane force. Swells from SE.

6 p. m.—Barometer 28.04; still falling. Heavy rains. Wind still N., hurricane force and increasing. Water rising on north side of island.

6:45 p. m.—Barometer 27.90. Wind backing to NW., increasing; plenty of flying timbers and heavy timber, too—seemed it made no difference as to weight and size. A beam 6 by 8 inches, about 18 feet long, was blown from north side of camp, about 300 yards, through observer's house, wrecking it and nearly striking 3 persons. Water 3 feet from top of railroad grade, or about 16 feet.

7 p. m.—We were now located in main lodge building of camp; flying timbers had begun to wreck this lodge, and it was shaking on every blast. Water had now reached level of railway on north side of camp. (ED. NOTE.—This was water rapidly piled up from the shallow expanse of Florida Bay, under the drive of northerly hurricane winds.)

9 p. m.—No signs of storm letting up. Barometer still falling very fast.

9:20 p. m.—Barometer 27.22 inches; wind abated. We now heard other noises than the wind and knew center of storm was over us. We now head for the last and only cottage that I think can or will stand the blow due to arrive shortly. All hands, 20 in number, gather in this cottage. During this lull the sky is clear to northward, stars shining brightly and a very light breeze continued; no flat calm. About the middle of the lull, which lasted a timed 55 minutes, the sea began to lift up, it seemed, and rise very fast; this from ocean side of camp. I put my flashlight out on sea and could see walls of water which seemed many feet high. I had to race fast to regain entrance of cottage, but water caught me waist deep, although writer was only about 60 feet from doorway of cottage. Water lifted cottage from its foundations, and it floated.

10:10 p. m.—Barometer now 27.02 inches; wind beginning to blow from SSW.

10:15 p. m.—The first blast from SSW., full force. House now breaking up—wind seemed stronger than any time during storm. I glanced at barometer which read 26.98 inches, dropped it in water and was blown outside into sea; got hung up in broken fronds of cocoanut tree and hung on for dear life. I was then struck by some object and knocked unconscious.

September 3: 2:25 a. m.—I became conscious in tree and found I was lodged about 20 feet above ground. All water had disappeared from island; the cottage had been blown back on the island, from whence the sea receded and left it with all people safe.

Hurricane winds continued till 5 a. m. and during this period terrific lightning flashes were seen. After 5 a. m. strong gales continued throughout day with very heavy rain.

The wind lulled briefly between 8 and 9 p. m. at Alligator Reef, with direction shifting sharply from northeast to southeast; this point was just at the northern edge of the calm center. A calm of 40 minutes' duration was experienced on Lower Matecumbe Key; and, as reported above, there was 55 minutes' respite at Long Key fishing camp, but the wind changes at the latter point indicate that the geometric center passed slightly to northward. It is somewhat difficult to reconcile these reports with the general storm path. The rate of progression over this section of the track was about 10 miles per hour, however, and from this it is estimated that the calm center was perhaps 8 miles in diameter.

The loss of life on the Keys was very heavy. Three populous relief work camps inhabited by war veterans were destroyed. The best estimate of mortalities, furnished by the American Red Cross, places the total at 409, of which number 244 are known dead and 165 missing.

The rescue of survivors was greatly hampered by lack of all means of communication and transport; but the Coast Guard promptly threw into the work 18 cutters, tugs, and patrol boats, 5 amphibian planes, and other facilities. The Red Cross and other public and private agencies of rescue were also promptly at work, so that the aftermath of mortalities from injuries and lack of supplies was held to a minimum.

After passing the Keys, the hurricane moved slowly into a broad recurve northward, closely parallel to the west coast of the Florida Peninsula, to pass inland, on the afternoon of September 4, over the Gulf coast between Apalachicola and Cedar Keys. The times of lowest barometer at various places along the coast northward from Key West give a good indication of the rate of progress. At Everglade (on the west coast about opposite Miami) the lowest barometer reading was 29.69 inches 6 a. m., September 3; at Egmont Key (entrance to Tampa Bay), 28.94, 11 p. m. of the 3d; and at Cedar Keys, 29.08, 1:50 p. m. of the 4th.

A slow increase in hurricane area took place along this part of the path, coincident with a decrease in central intensity, although the storm was still of hurricane force when it passed inland. Considerable damage to buildings, docks, and fishing craft occurred on the west coast, especially at Cedar Keys, and three lives were lost.

Northward along the west coast of the peninsula the tides shifted from abnormally low stages produced by the high offshore winds of the front quarter, to a heavy but not disastrous rise as the onshore winds in the rear of the storm came into play. Tides at many places on that coast rose 5 feet or more above normal, after the passage of the trough line; and the town of Cedar Keys experienced the highest tide and worst flooding since 1896.

During September 5 the storm moved from Georgia across the Carolinas, attended by high winds and heavy rains that caused some damage to property and crops, especially in southern Georgia. On the morning of September 6 the center of disturbance passed again into the Atlantic near Cape Henry, Va., where the lowest barometer was only 29.31 inches, showing that there had been a great decrease in intensity of the storm during progress over the Atlantic coastal plain.

The cyclone deepened again on moving out to sea; and on the morning of September 7 the American steamer *Excelsior* recorded a barometer reading of 28.46 with a whole gale from the south, shifting suddenly to storm force from the north, near 42° N., 54° W. The central minimum continued below 29 inches for two days longer. The American steamer *Black Condor* recorded 28.02 inches on the evening of the 8th, near 51° N., 31° W.; and on the 9th the Danish ship *Frederick VIII* recorded a reading of 28.73 inches near 55° N., 35° W., a considerable distance from the center. The cyclone was at that time diminishing in intensity and merging with another, so that by the 10th it could no longer be distinguished from the cyclonic condition commonly present at high latitudes in the North Atlantic Ocean.

Winds of hurricane strength were reported by a number of vessels along the track of this storm in the North Atlantic, the first such report coming from the American steamship *Quirigua*, which encountered the rapidly deepening cyclone on the 6th when less than 100 miles off the Delaware coast. The last reports of hurricane winds came from ships near mid-ocean, on the 8th.

Total property losses entailed by this hurricane are very difficult to estimate, but doubtless exceed $6,000,000; practically all the loss was suffered in Florida, and most of it over the Florida Keys.

Warning service began on August 30, when the first strong indications of an incipient cyclone were noted

northward of Turks Islands. Warnings and advices followed at frequent intervals thereafter, outlining the development and forecasting the progress of the storm area, until the night of September 6, when the disturbance was moving rapidly northeastward, well out in the Atlantic Ocean.

During the developing stage of the hurricane, as it was moving over remote islands and shoals of the southern Bahamas where there were no ships or island stations to report the passage of the small vortex, the problems of accurately locating the center and its line of advance and of forecasting its probable movement were extremely difficult. Nevertheless, timely and generally accurate advices were issued by the forecast center at Jacksonville, Fla., during this period. Two examples from this series of frequent advisory bulletins will illustrate their character:

Jacksonville, Fla., September 1, 1935.—Advisory 9:30 a. m. Tropical disturbance central a short distance south of Andros Island moving westward about 8 miles per hour attended by shifting gales and probably winds of hurricane force over a small area near the center. Indications that storm will pass through Florida Straits late tonight or Monday. Caution is advised vessels in path. Northeast storm warnings displayed, Fort Pierce to Fort Myers.

Jacksonville, Fla., September 2, 1935.—Advisory 3:30 a. m. Tropical disturbance still of small diameter but considerable intensity is moving slowly westward off the coast of north-central Cuba, attended by shifting gales and probable winds of hurricane force over a small area. It will probably pass through the Florida Straits Monday. Caution is advised against high tides and gales on the Florida Keys and for ships in its path.

The progress of the hurricane northward and northeastward beyond the Florida Straits was fully covered by forecasts and timely warnings issued in turn from the Jacksonville and the Washington forecasting centers, as the storm moved from the one district into the other.

WEST INDIAN HURRICANE, SEPTEMBER 23 TO OCTOBER 2, 1935

By W. F. McDONALD

[Weather Bureau, Washington, October 1935]

While the history of this disturbance is continuous from the afternoon of September 23 until October 2, there is a period of 36 hours, September 26 and 27, during which the characteristics and movement of the storm are obscure and apparently abnormal.

The first positive indication of a disturbance of sufficient vigor to be classed as a definite tropical cyclone was an observation of southwest wind, force 4, with rain and a confused sea, reported by the American S. S. *San Gil*, 7 p. m. of the 23d, when near 14° N., 75° W. A closed isobar of 29.8 inches also appeared on the synoptic chart over the general area northwestward from this position.

A broad but relatively weak cyclonic circulation persisted during the 24th and most of the 25th, and the evidence indicates that a developing center was probably moving westward on these dates, near the fifteenth parallel. At 11 p. m. of the 25th, the American tanker *A. C. Bedford* experienced a minimum barometer of 29.13 inches attended by west-northwest hurricane winds, her position being then very near 15° N., 80° W. This is the lowest barometer reading, and the only ship to report hurricane winds over the Caribbean Sea in connection with this hurricane. (See chart XI for the synoptic situation on the morning of Sept. 26.)

The disturbance appears to have progressed at a very slow rate during the 26th, and to have taken a recurving path toward the western end of Jamaica. Data from ships' reports and island stations are too meager to permit reconstruction of the full history of storm activities during the 27th. It is certain, however, that the center of action shifted rapidly during that day, with the result that there were high winds and excessive rains in Jamaica, causing heavy damage to the banana crop.

There seems little doubt that a minor disturbance, which moved during October 23 to 26 from its origin near St. Lucia toward Jamaica, joined the major cyclone on the 27th and contributed to the excessive rainfall and gale conditions that caused so much damage to the banana crop in Jamaica on the 27th. The progress of this minor disturbance westward was marked by heavy rainfall and local gales, first in Puerto Rico on the 24th, and the next day in southern Santo Domingo.

However, only one cyclonic center passed northward near Cayman Brac on the afternoon of the 27th. This was of hurricane violence, and caused great damage to buildings and crops on the island, although no lives were lost there inasmuch as the inhabitants had taken warning from radio advices and found shelter in available caves.

Early on the 28th, the city of Cienfuegos, Cuba, was seriously affected by passage of the hurricane center, with lowest barometer unofficially reported at 719 mm (28.31 inches). There was heavy property damage in Cienfuegos, Cumanay Agua, and other Cuban localities, as the hurricane crossed the island, and the casualties in Cuba were estimated at 35 deaths and possibly 500 injured. Much damage was due to the floods that attended the passage of the storm.

During the 28th the hurricane moved from the north coast of Cuba into a broad recurve that carried the center over the island of Bimini, where at 12:20 a. m. of the 29th, the wind shifted from southeast to northwest. The last barometer reading to be received from Bimini was 27.90 inches, at 11 p. m., more than an hour in advance of passage of the center which was doubtless marked by considerably lower minimum pressure. Highest wind was estimated at 120 miles per hour.

The tide is reported to have risen 15 feet at Bimini. More than half of the dwellings on the island were damaged and 14 persons killed.

At Miami, Fla., the lowest barometer was 29.35 inches, at 9:45 p. m. of the 28th, and the maximum wind was from northeast, 40 miles per hour. Fowey Rock Lighthouse, 12 miles southeast of Miami, experienced hurricane winds from the north, estimated at maximum to have been about 85 miles per hour, with a barometer reading of 29.24 inches.

Passage of the hurricane northward from the Cuban coast was completely covered in Weather Bureau warnings and advices issued from the forecast center at Jacksonville. At 8 a. m. of the 28th, warnings of "possibly hurricane winds" were issued for the southeast Florida coast, West Palm Beach to Key West. As the recurve became evident during the afternoon, announcement of this development was made at 5 p. m.; and at 7 p. m. the Miami area was notified that winds would not reach hurricane force at that place.

After passing Bimini, the hurricane moved steadily northeastward through the 29th and 30th; on October 1 the center took a course northward across the 60th meridian, and on the 2d merged with another depression over